THE USE OF LABORATORY TESTS TO STUDY OIL CONTENT IN INJECTION WATER WHICH TEND TO FORM EMULSION BLOCK AND CAN CAUSE PLUGGING IN RESERVOIR ROCK

by :

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ABSTRACT

Oil content plays important role in determining injection water quality before the injection water is injected into reservoir for water flooding need. Determination of oil contents laboratory tests were carried out on five injection water samples from different gathering stations. The results of tests show that two of five injection water samples contain oil contents which fulfill MIGAS guidelines (25 ppm) requirements specification. Whereas, oil contents in the three injection water samples are in a range of 38.00 ppm and 77.00 ppm. The values of oil contents exceed MIGAS guidelines and tend to form emulsion block and cause the occurrence of plugging in reservoir rock.

Key words: Oil contents, injection water, identification, emulsion block, plugging, formation.

I. INTRODUCTION

It is conventional knowledge that oil and water do not mix, but oil field operators know well that such is not case. In fact, a great deal of effort is spent in oil field operations to separate mixtures of oil and produced water. The produced water which is separated from petroleum products may be disposed of as a waste product, or it may be processed and re-injected into reservoir [1,2,7]. If the water is disposed of as waste, it is usually necessary to meet quality standard specified by environmental protection authorities. SPE 27177 with topic produced water treatment discussed the systems in operation to separate oil, gas and water to provide oil for export, gas for power generation and water for re-use and return to the environment. The systems operate quite effectively and under normal operating conditions the produced water remains within the MIGAS Guidelines and the PERTAMINA/CPI goals of 25 ppm oil content and temperature of 45 ^oC in order to protect the environment. Increasing production and maturation of the fields mean that there is an ever increasing amount of produced water to treat and that will require continuing efforts to maintain quality [3,7]. This paper is focused on three laboratory tests, these are firstly, to identify produced water whether contains oil content or not. Secondly, to determine how much oil content exists in the produced water. Thirdly, to know whether the produced water has a tendency to form emulsion block problem or not in water flood system. Therefore, topic of this paper is the use of laboratory tests to study oil contents in injection water samples which tend to form emulsion block and can cause plugging on reservoir rock.

II. OIL CONTENTS ANALYSIS

Infra red spectrometry is used to calculate oil content in produced water samples[9] . Principle of infra red spectrometry is to adsorb infra red. Infra red beam is adsorbed by each organic substance with different characteristics, so that the produced adsorption spectrum is specific for each substance. Relationship between adsorption with concentration can be explained by Lamber-Beer law. This law express connection between continued intensity (It) and initial intensity (Io) in a medium with certain thickness. It can be written mathematically:

$A = \log (Io/It) = a \times b \times c$

Where:

A = Absorbance.

a = adsorption coefficient.

b = medium thickness

c = concentration

In practice, a and b values are constant, so that equation above shows straight line equation. Oil content (ppm) in water sample can be calculated in the equation below.

$$ppm = \frac{1000 \times A \times Vol.CCl_4 \times fp}{Vol.sampel \times a_{(std)}}$$

A = Absorbance

Fp = dilution factor

Vol. CCl_4 = volume CCl4

a = adsorption coeffieceient

Figure 2.1 is infra red spectrometry equipment. Before the infra red spectrometry equipment is used to determine oil content produced water sample, at first, the equipment has to be calibrated in order to an accurate laboratory test result. A spectrum standard solution in Figure 2.2 shows CH_3 and CH_2 hydrocarbon groups, which CH_3 appears 2960 cm^{-1} and CH_2 at 2925 cm^{-1} at wavelengths. While, an example of analyzed water sample spectrum can be seen in Figure 2.3.

When injection water which has high oil content and is injected into reservoir as displacement fluid in water flooding process, will results in emulsion block and can cause plugging in reservoir rock[4,5,6,8]. Figure 2.4 describes occurrence of plugging on reservoir rock caused by emulsion block occurrence.

Figure 2.1
Infra red spectrometry equipment

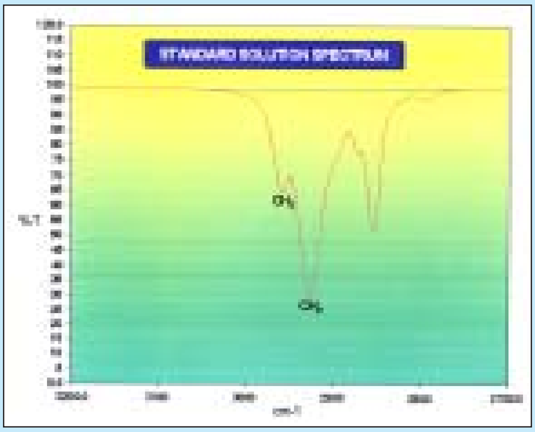

Figure 2.2
Standard solution spectrum

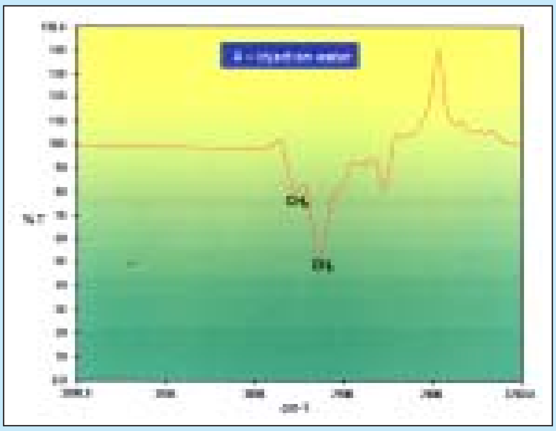

Figure 2.3
An example of analyzed water sample spectrum

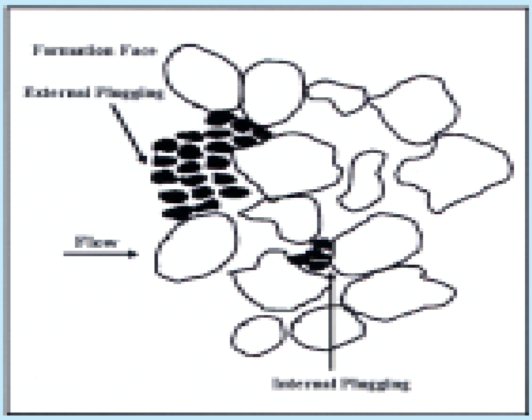

Figure 2.4
Occurrence of emulsion block can cause plugging on reservoir rock

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III. RESULT AND DISCUSSIONS

In this investigation, laboratory tests are focused three points, these are:

1. Identification of produced water or injection water sample whether the sample contains crude oil or not.
2. If, the water sample containing crude oil, how much concentration of oil content exists in the water sample.
3. Water sample fulfills or not quality standard specified by MIGAS guidelines (25 ppm oil content).

Water and crude oil were produced together from production wells, then the water and crude oil were separated, after separation, produced water was placed in gathering station (GS). The produced water sample in gathering station will be used as injection water in water flooding process. Five injection water samples which were analyzed in this research:

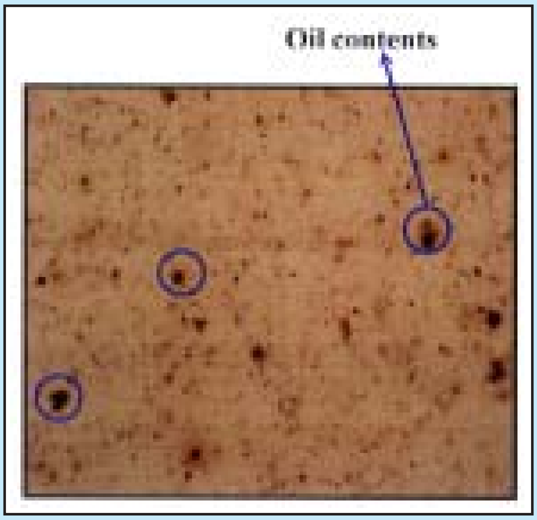

Figure 3.1
Oil content is found in A – GS

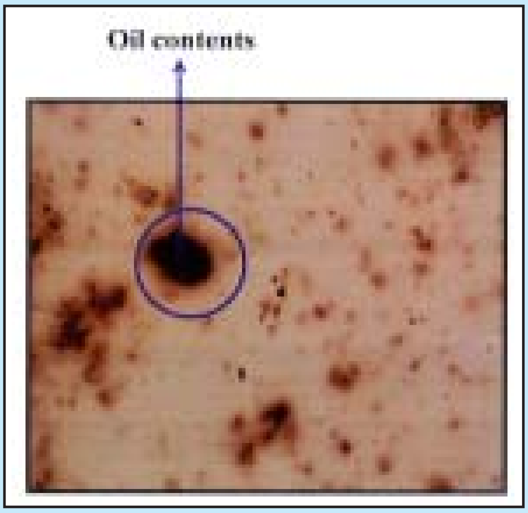

Figure 3.2
Oil content is found in A – GS

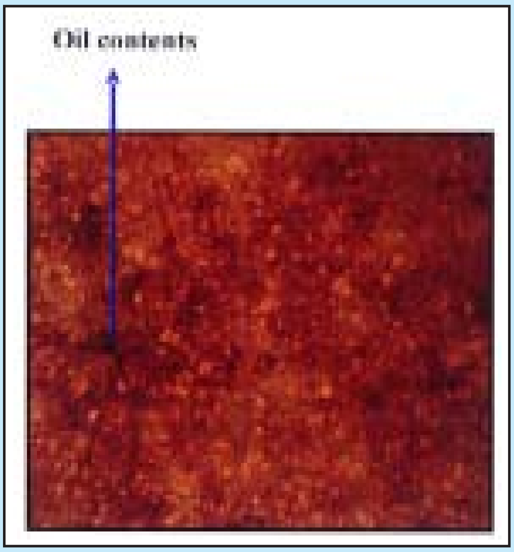

Figure 3.3
Oil content exists in B – GS

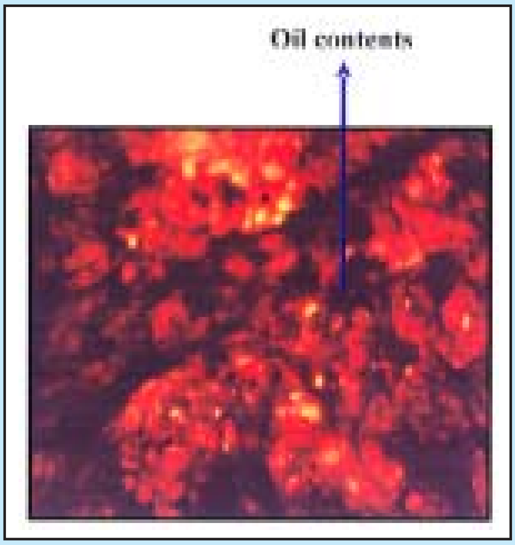

Figure 3.4
Oil content is obtained in R – GS

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1. A water sample from A - GS.
2. P water sample from P - GS.
3. B water sample from B - GS.
4. R water sample from R - GS
5. D water sample from D - GS.

Laboratory tests were carried out on A, P, B, R and D water samples from different gathering stations. Each injection water sample was filtered with using certain filter paper size (e.g. 10 mð). From this test, total suspended solids were obtained. To identify whether the solids particles contained crude oil or not, microscope camera was used to see existence of crude oil content in analyzed samples. Figures 3.1 to 3.5 show results of oil content identification of five analyzed samples. It can be seen clearly that each samples contains crude oil.

Determination of oil contents in all injection water samples were carried out by infra red spectrometry equipment. The results are tabulated in Table 3.1. Subsequently, the obtained oil contents in the analyzed samples were compared with permitted oil content based on quality standard of MIGAS Guideline (25 ppm oil content). Based on laboratory tests presented in Figure 3 - 6, the obtained oil contents in A – GS and P – GS injection water samples are 5.92 and 5.27 ppm. Both water samples don't show to form emulsion block, because the oil contents are less than 25 ppm. However, B – GS, R – GS and D – GS injection water samples contain oil contents more than 25 ppm. The found oil contents for B - GS, R – GS and D – GS are 77, 44.70 and 38 ppm respectively. In water flooding process, when injection water contains high oil content, is injected into reservoir, problem of emulsion block, decrease of displacement efficiency and occurrence of plugging will happen in the reservoir rock. Based on laboratory tests results, when the three injection water samples of B - GS, R – GS and D – GS will be used as displacement fluid in water flooding process, special treatment should be given on the three water samples, because these have high tendency to form emulsion block which can decrease displacement efficiency and cause plugging in reservoir rock or formation (as described in Figure 2.4).

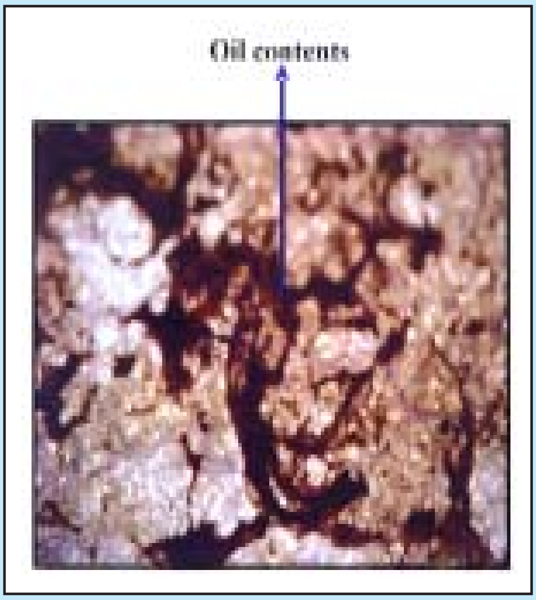

Figure 3.5
Oil content is found in D – GS

Table 3.1
Oil contents in injection water samples

No.	Injection water sample	Oil content (ppm)
1	A - GS	5.92
2	P - GS	5.27
3	B - GS	77.00
4	R - GS	44.70
5	D - GS	38.00

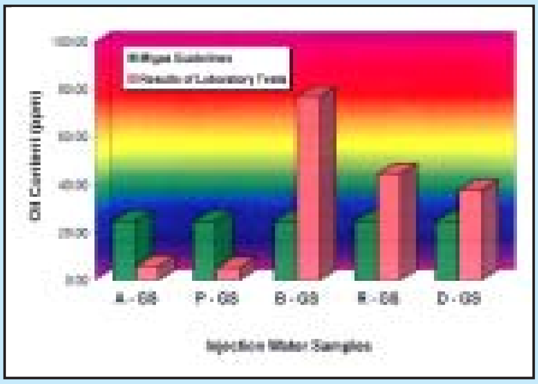

Figure 3.6
Comparison of oil contents in injection water samples and MIGAS Guidelines

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IV. CONCLUSIONS

All laboratory tests results can be concluded as follows:

1. A - GS, P - GS, B – GS, R – GS and D – GS are injection water samples taken from gathering stations. Results of identification for all analyzed water samples can be seen in Figures 3. 1 to 3.5 which describe that oil contents are found in the water samples.
2. The obtained oil contents in A – GS, P – GS, B – GS, R – GS and D – GS injection water samples are 5.92, 5.27, 77.00, 44.70 and 38.00 ppm respectively.
3. A – GS and P – GS don't have a tendency to form emulsion block, because oil contents in both samples are less than 25 ppm. However, B – GS, R – GS and D – GS tend to form emulsion block strongly, because these have high oil contents with a concentration range of 2-3 times higher than MIGAS guidelines.

REFERENCES

1. Charles, R.S.: “Secondary Oil Recovery“, Lition Educational Publishing, INC. Florida, p.183 – 224, 1966.
2. Jones, L.W., 1988, “ Corrosion and Water Technology For Petroleum Producers”, OGGI Publication.
3. McCune.C.C, SPE-AIME, Chevron Oil Field Research Co., “On-Site Testing To Define Injection-Water Quality Requirements.
4. Ostroff. A.G., 1965, “ Introduction to Oilfield Water Technology” New Jersey.
5. Patton. Charles.C., 1986, “ Applied Water Technology”, First Printing, June, , Oklahoma, USA.
6. Patton. Charles. C., 1977, “Oilfield Water System”, Norman, Oklahoma.
7. Marsid. M. and Suwito. S : “Produced Water Treatment”, SPE 27177.
8. Evans. R.C and Serck Baker Fluids System Consultants: ”Developments in Environental Protection Related to Produced Water Treatments and Disposal (Produced Water Re-Injection)”, SPE 27179.
9. API – RP 45 Recommended Practice for Analysis of Oilfield. ˘